NOAA Office of Ocean Exploration
FY 2006 Expeditions
Cruise Plan Revision

"Sonar Mapping Of Biologically-Engineered and Other Complex Habitats at the Shelf Edge and Upper Slope of the South Atlantic Bight"

NOAA Ship *Nancy Foster*
19 August 2006 - 1 September 2006

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Cruise Overview

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Vessel Identification and Cruise Number

NOAA Ship *Nancy Foster*
NF-06-10-OE

Study Areas

South Atlantic Bight, Cape Fear to northern Florida (Fig. 1-2). The survey on the upper slope and Blake Plateau (Fig. 1) will concentrate on wreckfish catch locations that coincide with proposed coral Habitat Areas of Particular Concern (HAPC) that have not been previously surveyed. The surveys on shelf-edge reef spawning grounds and proposed Marine Protected Areas (MPAs) will concentrate on MPA sites off South Carolina.

Because of the expansive geographic area being considered, we proposed concentrating on important fishery grounds to map Essential Fish Habitat (EFH). Mapping will concentrate on reef fish spawning grounds at the shelf edge and upper slope, particularly those that occur in proposed MPAs and in suitable habitats that are not being considered for additional protection as MPAs. We will also concentrate on shelf-edge and upper slope locations where we expect to find biologically-engineered habitats such as locations where excavating fishes (tilefishes, red grouper, gray triggerfish) are found (e.g. Fig. 2). We will also direct sonar mapping efforts toward historical or recently-mapped locations of coral mounds on the continental slope and Blake Plateau, including proposed deepwater coral HAPC (Fig. 1). The known coral mound areas are vast, and we will concentrate on those areas off South Carolina, near the Charleston Bump, where we have observed fishery species (wreckfish, *Polyprion americanus*) associated with coral mounds, and where we have conducted submersible dives. EFH to be mapped includes shelf-edge reefs (45-100 m depths) and associated reef fish spawning sites, upper slope reefs (130-275 m depth), tilefish muds and pueblo habitats (165-275 m), deepwater coral (*Oculina, Lophelia, Dendrophelia*) banks (100-900 m), scarps and other complex bottom types. We will also map areas of extensive coral mounds, as these are important fish habitats and create complex refuges for a diversity of marine organisms. We will use existing data on fish and coral distribution to find locations to initially map, then use broad multibeam survey to locate habitats that have the potential to support these species.

Sonar surveys will initially concentrate on shelf-edge reefs in depths from 50 to 200 m, between Cape Canaveral, Florida and Cape Fear, North Carolina. Because of the extensive geographic coverage, efforts will initially concentrate on proposed MPA sites and known spawning grounds off northern Florida, Georgia, South Carolina and North Carolina. We are especially interested in MPA sites that include spawning sites of economically valuable fishes, but will also examine those MPA sites that possess species that excavate the bottom (Fig. 2), and which may be spawning there. Likewise, we will survey reefs that contain excavating and spawning species, but that are not proposed MPA sites, to determine the quality of proposed MPAs relative to other sites. Surveys will be conducted along complex bottom features (e.g. the shelf-edge reef), but will encompass adjacent smooth bottom.

Goals and Objectives

The goal of this project is to map fish habitats and unique bottom features, and to relate bottom features to occurrences of biological or physical forces that shape the bottom. To achieve this goal, we will address the following objectives:

1. Use multibeam sonar to map bottom topography in areas that are important fish habitats and spawning grounds, as determined from historical fishery-independent sampling, commercial landings and ongoing complementary studies already funded by NOAA.
2. Use side-scan and Chirp sonar to map smaller features (particularly features excavated by fishes), such as tilefish burrows, red grouper pits, low mounds built by tube worms, coral mounds, solution holes, gas seeps, and other small-scale features. Develop criteria for distinguishing pits made by gas or water seeps from pits made by fish and to distinguish between excavations made by different species (this will be done in 2007 using ROV to groundtruth sonar signals and develop criteria for identifying sonar signals.
3. Bring topography data into an existing GIS, to describe Essential Fish Habitat (EFH), Habitat Areas of Particular Concern (HAPC) and Marine Protected Areas (MPAs) for the South Atlantic Bight.
4. Correlate distribution of fishes (as determined from extensive historical databases housed at SCDNR) with distribution of habitats, topographic complexity and oceanographic features.
5. Develop educational materials from the research.

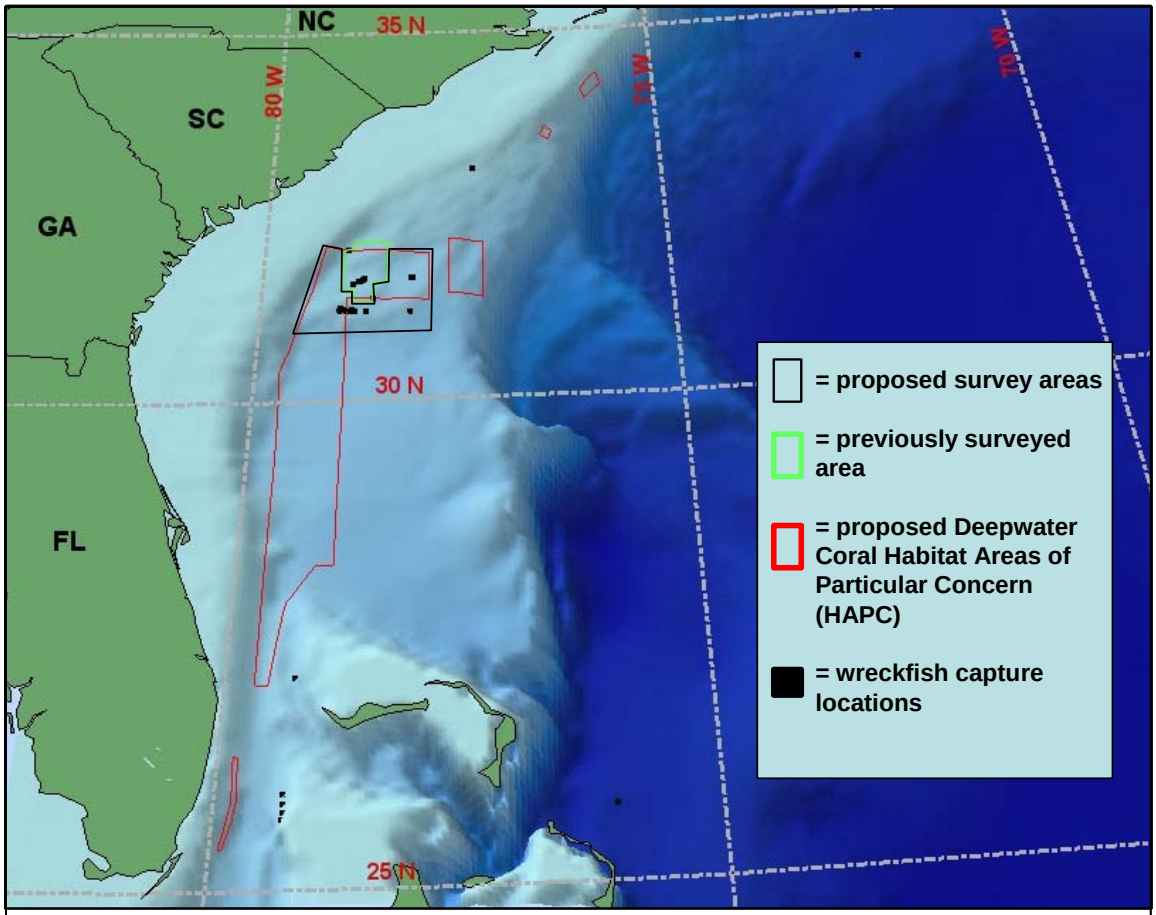


Fig. 1. Deepwater (300-900 m) coral areas originally proposed to be surveyed. This area includes rugged bottom topography and coral mounds that are important habitats for wreckfish (*Polyprion americanus*), and a small portion of the proposed deepwater coral Habitat Areas of Particular Concern. Previously surveyed areas include single-beam and multibeam sonar surveys conducted by the investigators on the Charleston Bump.

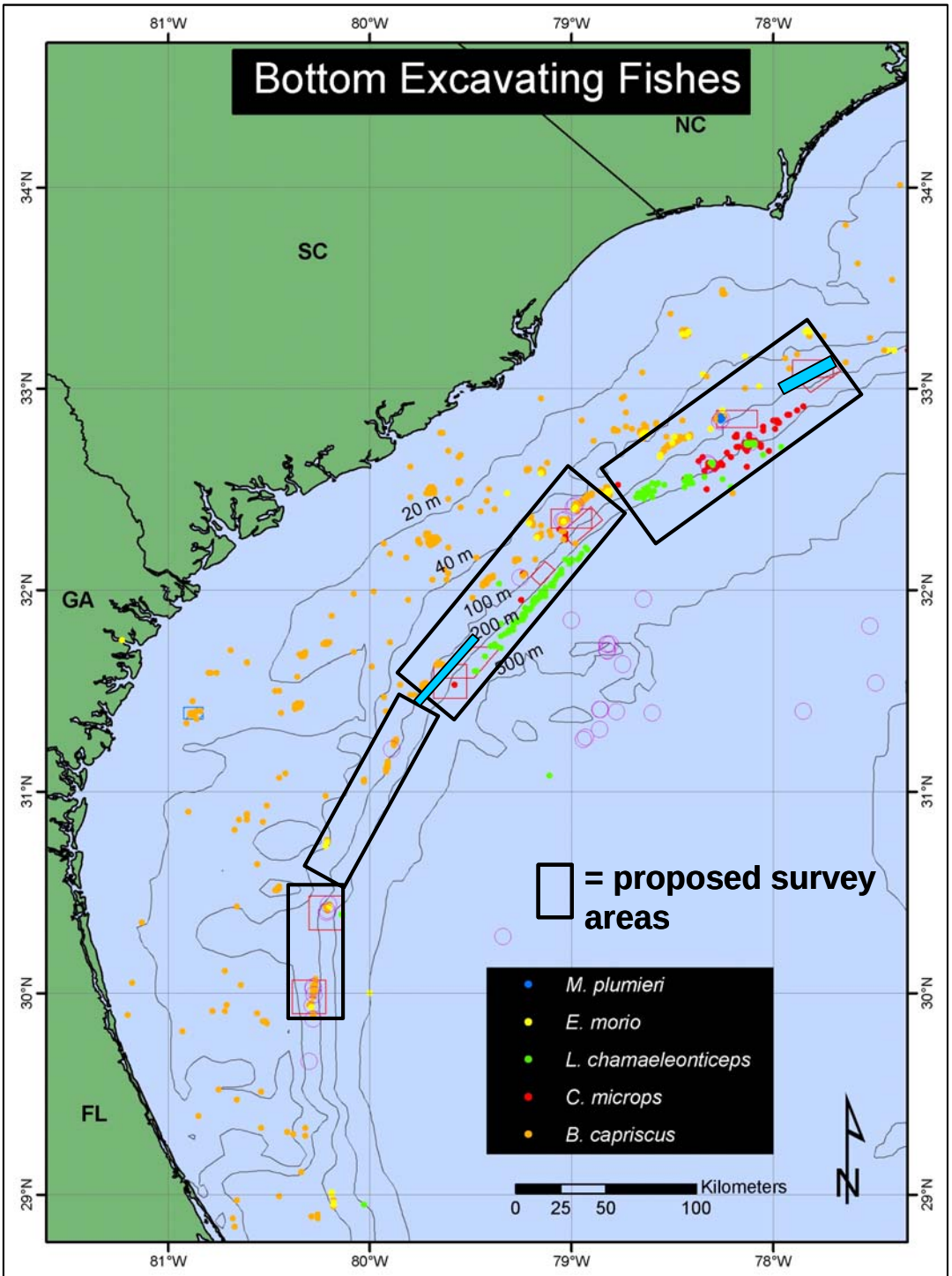


Fig. 2. Shelf-edge (40-100 m) and upper slope (130-225 m) areas to be surveyed. These areas include rugged and smooth bottom topography, proposed MPAs (red boxes), previous OE submersible dive sites (purple circles) and locations where we have collected bottom-excavating fishes (dots). Some multibeam sonar data are already available from NOAA Fisheries and NOAA Sanctuaries on parts of some of the proposed MPAs (blue boxes), and proposed work will concentrate in MPAs.

Description of Operations

Sonar Surveys

Surveys will be conducted along lines that parallel the bottom feature being surveyed, with occasional cross-transects to further validate initial survey readings. In areas where we find subbottom features of interest, Chirp sonar surveys will be run perpendicular to the bathymetry. Surveys will be conducted on two general scales. The broad-scale survey will be conducted at each site first, and will consist of high-resolution (4 m/pixel) multibeam sonar that will be used to map large-scale features within the proposed MPA sites and along similar reef features outside the proposed MPAs. Soundings will be recorded continuously using echosounders interfaced with GPS. Multibeam sonar data will be collected using a Multi-Beam 1002 Simrad System (30m-1000m) interfaced with Scientific Computer System (SCS) installed aboard the NOAA Ship *Nancy Foster*. The SCS includes a HYPACK Data Acquisition and Processing System, which will also record continuous data from the ship's Acoustic Doppler Current Profiler (ADCP).

A Sea-Bird SEACAT SBE-19 CTD or equivalent will be used to determine temperature and salinity profiles. Sound velocity profiles will be used to calculate sound velocity corrections for depth measurements. A dynamic motion sensor or heave, roll, pitch and motion sensor will collect heave, pitch and roll measurements to be applied to raw soundings data for correction during processing. Tidal time and ratio correctors will be obtained from NOAA/HSD and applied during at-sea post-processing to 6 min tidal values based on the Charleston (or other local) tide gauge. Positioning information will be collected using a Trimble DSM212L GPS Receiver or equivalent, with integrated DGPS VHF receiver. Differential corrections will be received from the Ft. Macon NC, Charleston SC or Miami FL radio beacons as appropriate. Antenna positions will be corrected for offset and layback and referenced to the position of transducer(s) in use at the time. Accuracy requirements will be met as specified in the NOAA Hydrographic Manual and Field Procedures Manual (FPM). The Horizontal Dilution of Precision and Estimated Position Error as specified in the FPM will be monitored during on-line data collection. If the positioning degraded beyond the acceptable limits while on line, the data will be either rejected or smoothed, depending on the extent of the affected data. Coastal Oceanographics HYPACK software or equivalent will be used for data acquisition. Processing of sounding data will be accomplished using NOAA Hydrographic Processing System included in HYDROSOFT 9.4, Mapinfo software, and the HPS-MI MapBasic application (or equivalent/upgrade). Post processing will be done using CARIS HIPS software that is used aboard the *Foster*. CARIS HIPS includes statistical-based data cleaning and processing, and data validation tools to translate raw sounding data into GIS-based maps and shapefiles.

Multibeam sonar surveys will be followed by side-scan and Chirp sonar transects through particular features of interest, or through areas where fish and coral species of interest have previously been observed or collected. Depending on conditions, it may be possible to conduct multibeam, side-scan and Chirp sonar simultaneously. A dual-frequency (100- and 500-Khz) towed side scan sonar (Klein 3000) provided by the investigators will be used to obtain detailed bottom maps along transects. Transect data will be digitally assembled into mosaics for each MPA site or area of interest. Post processing will be done using CARIS SIPS software. CARIS SIPS includes statistical-based data cleaning and processing, and data validation tools to translate raw sounding data into GIS-based maps and shapefiles. Habitat data from all sonar surveys will be incorporated into the GIS database (SEA-GEOFISH; http://www.csc.noaa.gov/seageofish/) containing historical data on hydrography and fish distribution, to aid in characterization of reef fish spawning sites and other habitats based on biological and physical data.

Ancillary Sampling

As time permits, we will conduct hook-and-line fishing (trolling) during multibeam sonar surveys, to obtain large pelagic fishes for tagging. Fishes will be tagged with satellite pop-up tags.

If time permits, a few plankton samples (10 max), using 60-cm bongo and 1 x 2 m neuston nets will be taken over known fish spawning sites, to collect larvae for confirmation of spawning.

All sampling gear for ancillary sampling will be provided by the investigators.

Itinerary

Sonar surveys will be accomplished on one 14-day cruise commencing and ending in North Charleston SC. Dr. Sedberry has previously obtained clearance from the U.S. Navy to conduct (and release data from) high-resolution sonar surveys in the proposed areas. He is in the process of having this clearance renewed.

Mobilization will occur in North Charleston on 18 August 2006, when the scientific party will load equipment and supplies on the vessel. The scientific party will stay aboard that night for departure on 19 August 2006. Shelf-edge, upper slope areas and Blake Plateau (50-225 m) between 33.5°N and 31.5°N will be surveyed. Demobilization will occur in North Charleston on 1 September 2006.

Surveys will occur in 5 x 5 nautical mile blocks, although some are adjacent to each other resulting in an effective 5 x 10 mile block. It is estimated that it will take 48 h to complete a multibeam survey in a block with an average depth of 50 m. If side-scan and Chirp sonar can be towed at the same time (maximum speed 8 knots), an entire block can be completed in 48 hr. If not, an additional 24 h will be spent using side-scan and Chirp sonar to survey specific features noted on multibeam surveys of each block. In addition, parts of the blocks may contain no features of interest and transects could be shortened. The following assumes that a 5 x 5 mile block can be completed in 48 hours.

Daily Operations

18 Aug 06: mobilization
19 Aug 06:
  0800: depart Charleston SC
  1700: arrive Block 1; begin multibeam/side scan/Chirp survey of Block 1
20 Aug 06: continue as before
21 Aug 06:
  1700: complete Block 1; begin Block 2
22 Aug 06: continue as before
23 Aug 06:
  1700: complete Block 2 survey; U/W for Block 3
  2200: begin multibeam/side scan/Chirp survey of Block 3
24 Aug 06: continue as before
25 Aug 06:
  2200: complete Block 3 survey; begin Block 4 survey
26 Aug 06: continue as before
27 Aug 06: complete Block 4 survey; begin Block 5 survey
28 Aug 06: continue as before
29 Aug 06:
  2200: complete Block 5 survey; U/W for Block 8
30 Aug 06:
  0300: begin multibeam/side scan/Chirp survey of Block 8
31 Aug 06: continue as before
1 Sep 06:
  0000: complete Block 8 survey; U/W for Charleston
  1200: arrive Charleston
  1200: demobilize

Survey times for each block are conservative (assuming towed gear can be deployed simultaneously with multibeam transects), as bottom features of interest may be confined to small portions of each block (e.g., the shelf-edge ridge along the 30-fm curve). Additional blocks have been designated to be surveyed if time allows (Fig. 3-8). Depending on conditions, Blocks 6-7 can be substituted for Block 8.

Figure 3. Sites and alternates for sonar survey. Each numbered block is about 5 x 5 NM; Block 8 is 5 x 20 NM. Also noted are previous SCDNR-OE submersible dive sites, proposed Marine Protected Areas, and capture locations for bottom-excavating fishes (sand tilefish, red grouper, tilefish, blueline tilefish and gray triggerfish).

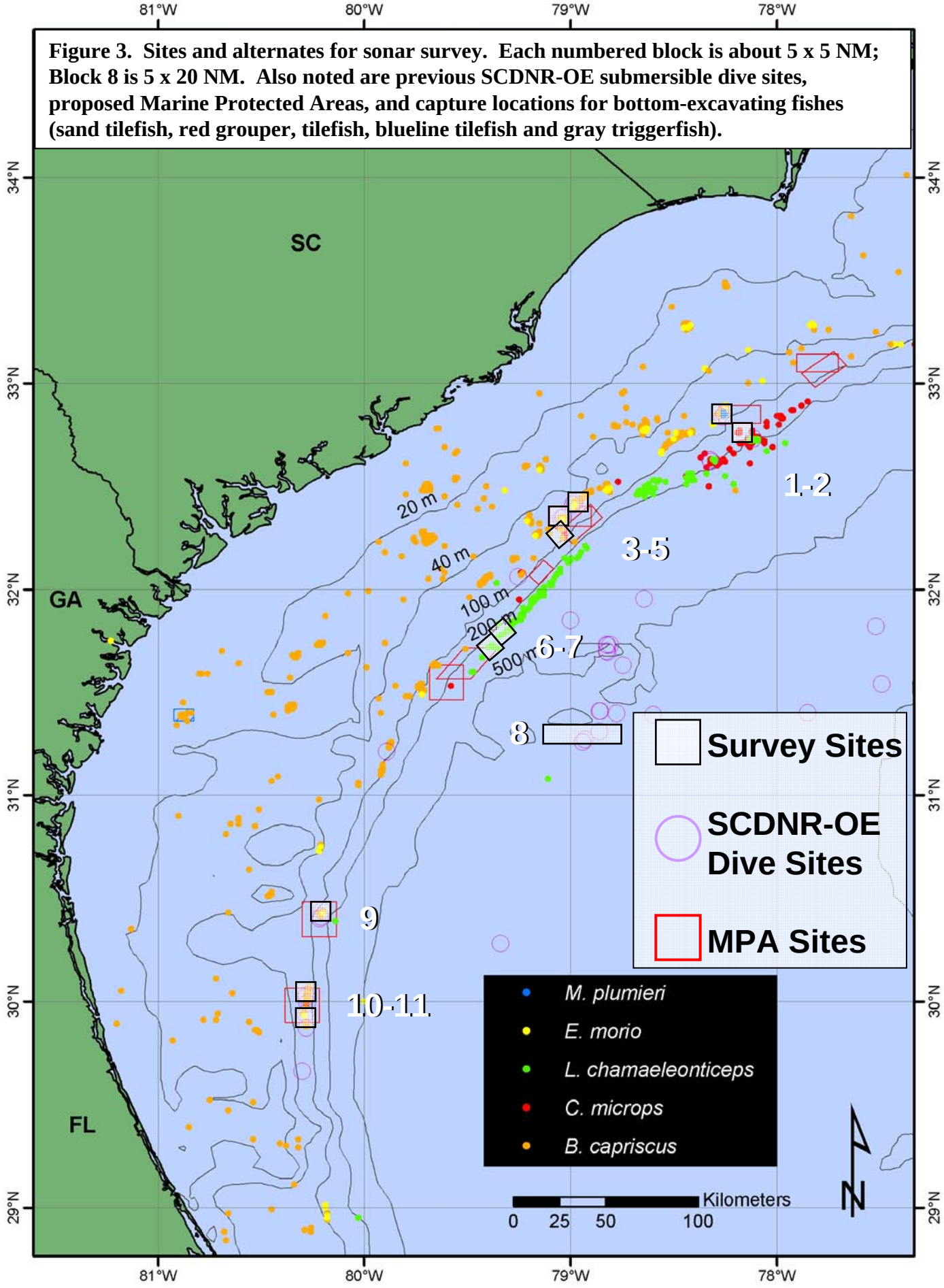


Figure 4. Details of survey Blocks 1 and 2, showing location in relation to proposed MPAs and capture locations of bottom-excavating fishes.

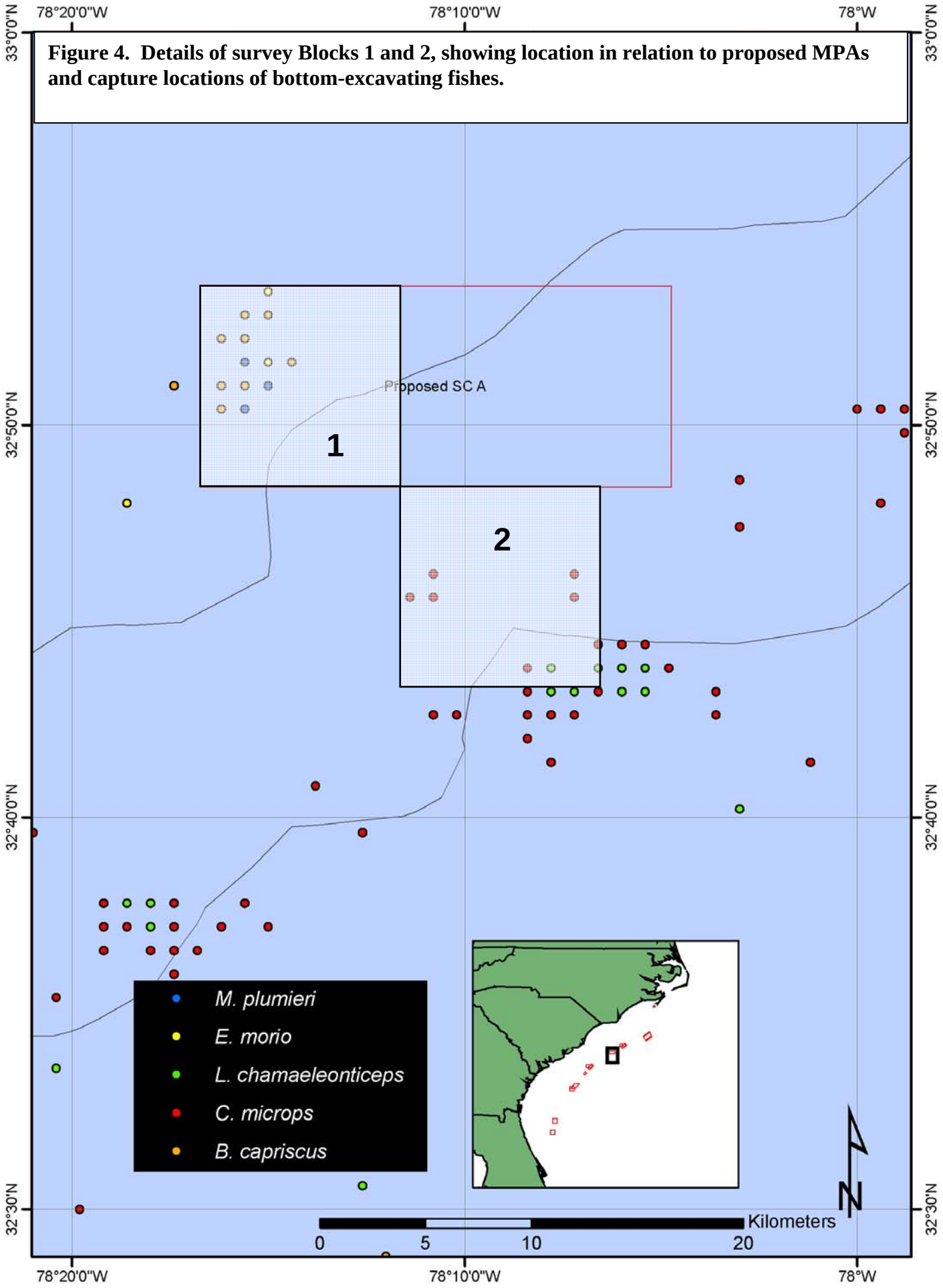
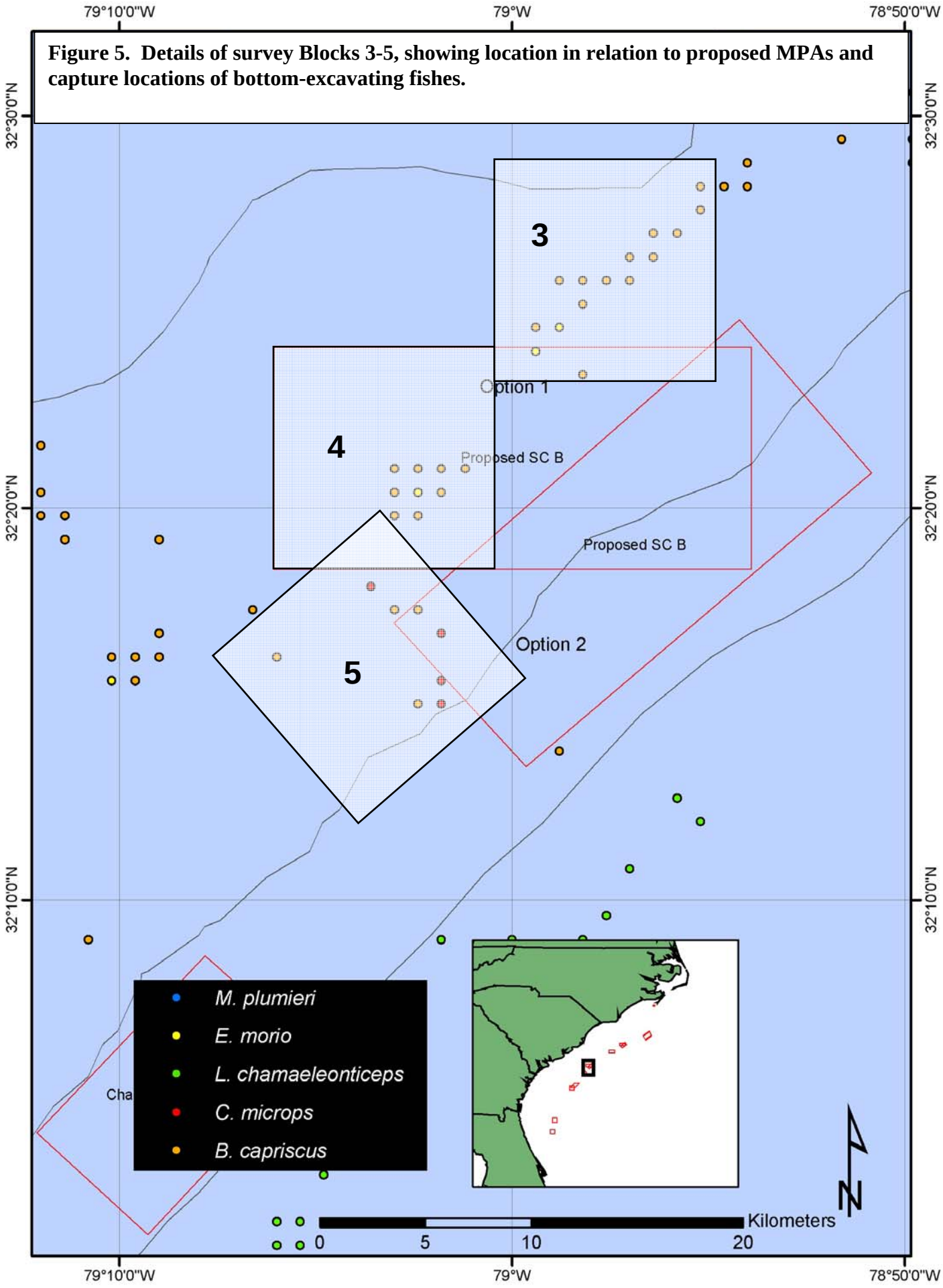


Figure 5. Details of survey Blocks 3-5, showing location in relation to proposed MPAs and capture locations of bottom-excavating fishes.



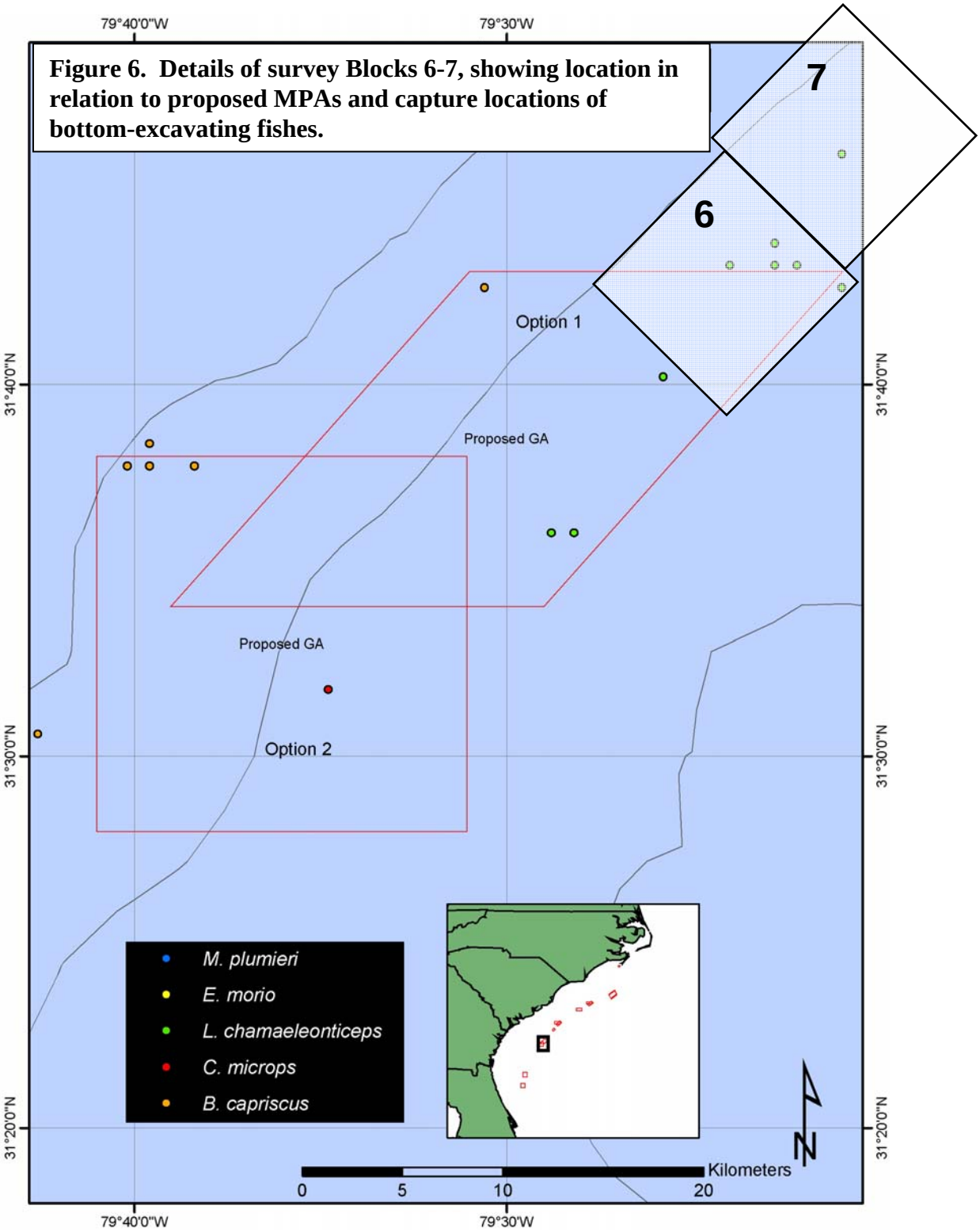


Figure 6. Details of survey Blocks 6-7, showing location in relation to proposed MPAs and capture locations of bottom-excavating fishes.

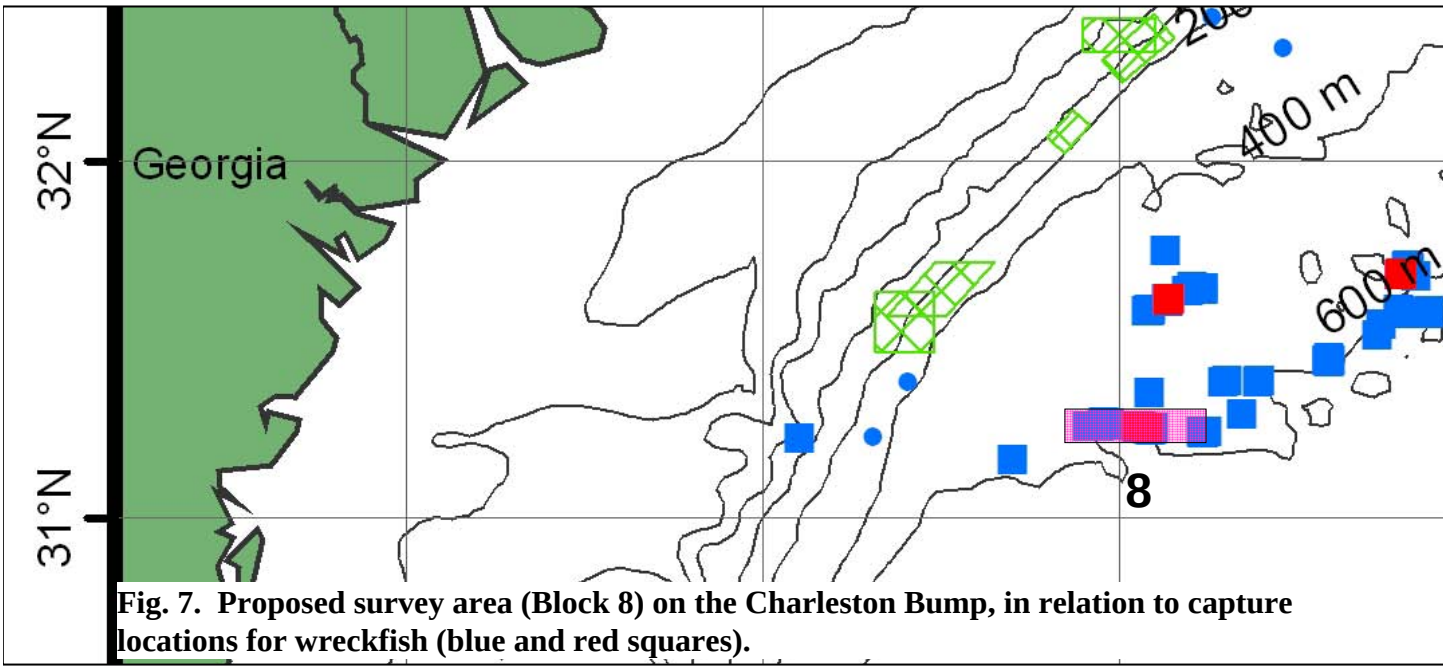


Fig. 7. Proposed survey area (Block 8) on the Charleston Bump, in relation to capture locations for wreckfish (blue and red squares).

Personnel and Organizational Structure

Personnel are from the South Carolina Department of Natural Resources (SCDNR), Coastal Carolina University (CCU), Scripps Institute of Oceanography (SIO) and the College of Charleston (Cof):
Beal, Marion (SCDNR)
Gayes, Paul (CCU): Watch Chief
Johnstone, Liz (SIO)
Meister, Scott (SCDNR)
Phillips, James (CCU)
Sedberry, George (SCDNR): Chief Scientist
Williams, Allison (SCDNR): Watch Chief
Wieber, Kim (CofC)

Equipment Lists

We will use the multibeam sonar system and CTD installed on the *Nancy Foster*. We will provide the side scan sonar equipment and Chirp, which includes a 9 x 122 cm (29 kg) tow fish, cable and associated digital recorders and computers.

Disposition of Data

Data will be retained by NOAA NOS and downloaded to external hard drives, backed up on DVD, for return to the SCDNR-MRRI laboratory for post-processing. The data will be entered into the MRRI database and stored on local servers. Appropriate cruise reports, quick-look reports and progress reports will be submitted to NOAA as required.

Emergency Information

Emergency contact information will be supplied on the NOAA Health Services Questionnaire (HSQ) forms.

Communications

The scientific party will be provided with shipboard email accounts for regular communications. Emergency communication will be done by shipboard satellite phone.

Miscellaneous:

HAZMAT Inventory

Full-strength ethanol (95%) will be used to preserve plankton samples. MSDS sheets will be provided (Appendix D).

Meals

The scientific party will take meals on the posted ship's schedule.

Appendices

Contact Information
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EXECUTIVE SUMMARY

Title: Sonar mapping of biologically-engineered and other complex habitats at the shelf edge and upper slope of the South Atlantic Bight

Investigators: George R. Sedberry, Principal Investigator, South Carolina DNR
Felicia C. Coleman, Florida State University
Christopher C. Koenig, Florida State University
Joshua K. Loefer, SCDNR
Leslie Sautter, Cooperating Investigator, College of Charleston
Kathryn M. Scanlon, U.S. Geological Survey, Woods Hole MA
Jessica A. Stephen, SCDNR
Philip Weinbach, SCDNR

Funding Requested: $166.000, plus ship and instrument time.

Objectives:

1. Use multibeam sonar to map bottom topography in areas that are important fish habitats and spawning grounds, as determined from historical fishery-independent sampling, commercial landings and ongoing complementary studies already funded by NOAA.
2. Use side-scan sonar to map smaller features (particularly features excavated by fishes), such as tilefish burrows, red grouper pits (depressions), low mounds built by tube worms, coral mounds, solution holes, gas seeps, and other small-scale features. Develop criteria for distinguishing pits made by gas or water seeps from pits made by fish and to distinguish between excavations made by different species.
3. Use ROV to groundtruth sonar signals and develop criteria in (2).
4. Bring topography data into an existing GIS built with separate NOAA funding, to describe Essential Fish Habitat (EFH), Habitat Areas of Particular Concern (HAPC) and Marine Protected Areas (MPAs) for the South Atlantic Bight.
5. Use GIS to correlate distribution of fishes (as determined from extensive historical databases housed at SCDNR) with distribution of habitats and topographic complexity.
6. Analyze existing OE samples and data collected in the SAB to add to the GIS and to put existing OE visual observations into a topographic setting.
7. Use GIS to incorporate separately-funded oceanographic data (including trajectories of satellite-tracked drifters deployed on proposed mapping sites) into habitat maps for the region, to elucidate recruitment patterns for reef fishes.
8. Develop educational materials from the research.

Methods and Rationale: We will use sonar and ROV to map coral and other EFH, including physically- and biogenically-formed bottom features of the outer continental shelf and upper slope. We will concentrate on important fishery grounds, particularly shelf-edge spawning grounds, in the first year. EFH to be mapped includes shelf-edge reefs (45-100 m) and associated spawning sites, upper slope reefs (130-275 m depth), tilefish muds and pueblo habitats (165-275 m), deepwater coral banks (100-1000 m), scarps and other complex bottom types. We will also map coral mounds, as these are important fish habitats and create complex refuges for a diversity of marine organisms. The proposed work will complement existing and historical NOAA programs that are mapping fish habitats using historical oceanographic and fish distribution data. The project will enable us to put historical data (e.g. fish distribution maps, hydrography and sediment/rock samples) in the context of surrounding bottom features, and to present the data on an internet map server.

PROJECT DESCRIPTION

Introduction, Background and Rationale

We propose an expedition to deploy state-of-the-art sonar to map coral areas, other Essential Fish Habitats (EFH), and physically- and biogenically-formed bottom features of the outer continental shelf and upper slope of the South Atlantic Bight (SAB). This project is aimed at discovering, surveying, and mapping complex habitats. These habitats consist of low- to high-relief hard grounds and rocky reefs, smooth and bioturbated muds, and biologically-engineered habitats such as grouper excavations, tilefish burrows, worm reefs and coral reefs. We are particularly interested in mapping EFH such as the spawning grounds of reef fishes, especially those species that form aggregations by migrating to specific locations or habitat features (Fig. 1). This mapping will complement previous and current NOAA-funded projects aimed at determining the factors that constitute spawning grounds for reef fishes, especially deep-reef species. Reef fish spawning locations and deep coral reefs (Fig. 2, Fig. 6) are considered Habitat Areas of Particular Concern (HAPC) by the NOAA Fisheries Service and the South Atlantic Fishery Management Council (SAFMC) (R. Pugliese, South Atlantic Fishery Management Council, pers. com., June 2004). EFH comprises HAPC, and sonar mapping and groundtruthing of sonar signatures of bottom features around known spawning locations are needed to determine the characteristics of these sites that make them attractive as spawning grounds for many reef fishes. By characterizing the sites with sonar (groundtruthed with visual observations), we can then use rapid sonar surveys to map other lesser-known or previously unknown spawning locations, and discover additional EFH and HAPC. Because deep reef fishes often spawn in deep coral banks (Gilmore and Jones 1992) and

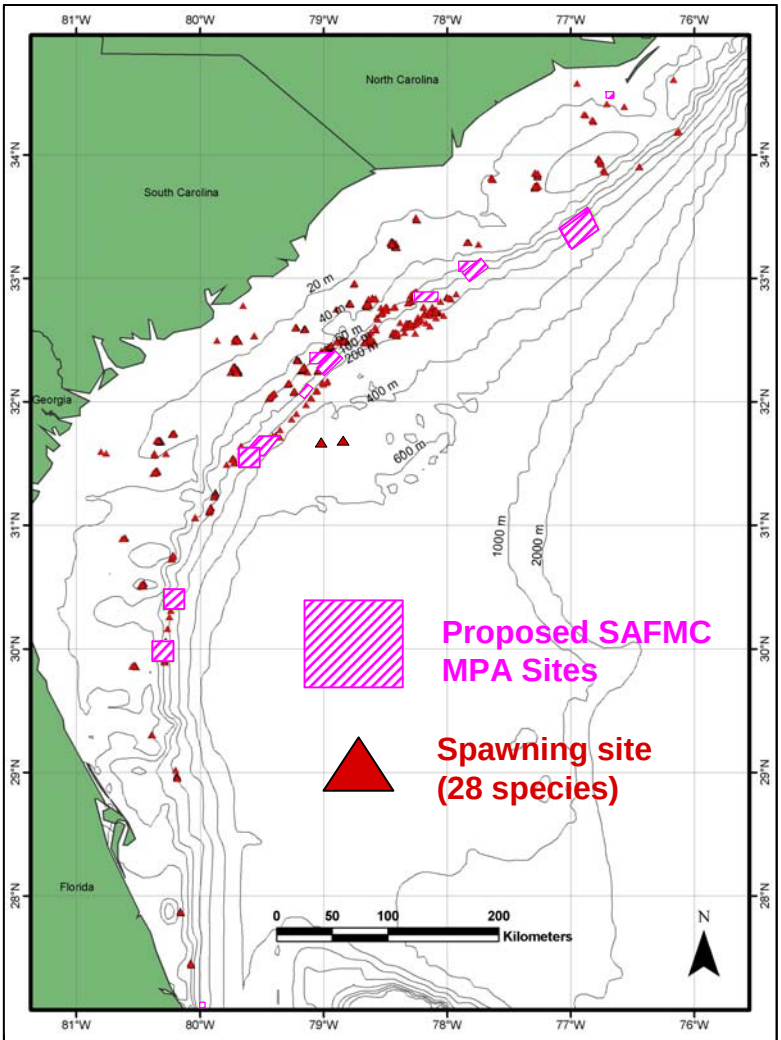


Figure 1. Spawning locations of 28 species of reef fish, in relation to Marine Protected Areas proposed by the South Atlantic Fishery Management Council. Many different species spawn at shelf-edge (50-100 m), slope (200 m) and Charleston Bump (400-600 m) reefs. The proposed bottom mapping efforts will concentrate on shelf-edge and slope reefs to characterize spawning reefs and to discover additional spawning sites.

other biogenically-altered bottoms, mapping location of those features (e.g. Fig. 2) will enable us to locate additional spawning grounds and other EFH. In addition, many fishes build nests (e.g. Fig. 3) during spawning (Fricke 1980; Lobel and Johannes 1980), or otherwise alter the bottom in ways that show up on sonar records (Barans and Stender 1993; Wenner and Barans 2001; Scanlon et al. 2005), and those records can be used to map spawning and residence areas for fishes that "bioengineer" the bottom.

Three-dimensional bottom complexity excavated by fishes or built up by corals and reef-building tube worms support numerous other organisms (Coleman et al. 2005; Fig. 3). Mapping of deep coral banks, and investigating their diversity and ecology, are important mission of NOAA OE and other NOAA initiatives. Our mapping will, therefore concentrate on complex habitats created biogenically by fishes and other organisms. Side scan sonar surveys of shelf edge reefs conducted by us on previous OE expeditions to the SAB revealed mounds, pockmarks and excavations (pits) similar to those seen in the Gulf of Mexico (Sedberry, Cooksey et al. 2004; Scanlon et al. 2005; Fig. 3). Such habitat modification by fishes (red grouper, *Epinephelus morio*; gray triggerfish, *Balistes capriscus*) and physical processes (e.g. gas seeps) create additional habitat complexity that is utilized by a variety of species, although the biological relationships and behaviors have not been thoroughly investigated (Scanlon et al. 2005).

Project Objectives

Our goal is to map bottom topography and complex habitat at the edge of the continental shelf and on the continental slope of the SAB. Achieving this goal will complement our previous OE expeditions that have observed and mapped spawning behavior, spawning sites and deep coral habitat for deep reef fishes in depths from 50 to 800 m on the shelf edge, upper slope and Charleston Bump (Sedberry, Cooksey et al. 2004; Sedberry, Andrus et al. 2005). It will also complement previous sonar surveys conducted by SCDNR and NOAA Marine and Aviation Operations in depths from 300 to 700 m on the Charleston Bump, Blake Plateau (Sedberry, Pashuk et al. 2004). We will address this goal by accomplishing the following objectives:

1. Use multibeam sonar to map bottom topography in areas that are important fish habitats and spawning grounds as determined from historical fishery-independent sampling, commercial landings and complementary studies already funded by NOAA.
2. Use side scan sonar to map smaller features, particularly features excavated by fishes, such as tilefish burrows and red grouper pits (depressions). We will also use side scan sonar to map low mounds built by tube worms, coral mounds, solution holes, gas seeps, and other small-scale features. Develop criteria for distinguishing pits made by gas or water seeps from pits made by fish and to distinguish between excavations made by different species
3. Use ROV to groundtruth sonar signals to develop criteria in (2)..
4. Bring topography data into an existing Internet map server (built with separate NOAA funding), to describe EFH, HAPC and MPAs for the SAB.
5. Use GIS to correlate distribution of fishes (as determined from extensive historical databases housed at SCDNR) with distribution of habitats and topographic complexity.
6. Analyze previous OE samples and data collected in the SAB to add to the GIS and to put visual observations we have made on previous expeditions into a topographic setting.
7. Use GIS to incorporate existing oceanographic data (including trajectories of satellite-tracked drifters deployed on proposed sites) into habitat maps, to elucidate recruitment patterns for reef fishes based on circulation and bottom topography.
8. Develop educational materials from the research.

Relevance to OE Mission and Our Previous OE Expeditions

Our previous experience in exploration of shelf-edge and slope depths in the SAB has indicated a variety of habitats, each comprising different fish assemblages, including many economically valuable and overfished species. We have begun to describe fish and invertebrate assemblages associated with specific bottom features that can be seen on standard ship fathometer (with some limited multibeam sonar data from the Charleston Bump), but we do not have extensive high-resolution sonar surveys to determine the extent of this habitat and, thus, the range and potential biomass of reef fish assemblages. Our OE side-scan sonar explorations (in 2002) at shelf edge reefs off South Carolina in revealed pockmarked bottom and low mounds at shelf edge reefs of the SAB, similar to that seen in the Gulf of Mexico (Fig. 3; Scanlon et al. 2005). It is believed that some of these bottom features are actually created by fishes, but additional mapping and investigation is needed (Scanlon et al. 2005).

We will link extensively with the OE missions of mapping features and exploring their biota. We will address several OE mission objectives:

Ocean Mapping and Bathymetry: We will deploy multibeam, side-scan, and conventional sonar from a NOAA survey ship to map distribution of simple and complex bottom features. We will use multibeam sonar to map features on a broad scale (km), and to locate areas such as reefs, scarps and bioturbated bottom that indicate fish habitat. We will examine specific features constructed by fishes, such as red grouper pits and tilefish burrows (blueline tilefish, *Caulolatilus microps*; tilefish, *Lopholatilus chamaeleonticeps*; sand tilefish *Malacanthus plumieri*), using side scan sonar, and map the extent of these bio-engineered habitats.

Marine life inventories and Census of Marine Life: Sonar surveys will give us rapid, extensive maps of habitats such as reefs that support diverse and abundant marine life, as well as habitat that is constructed by marine life (fish burrows; coral mounds), thus indicating the presence of those species. We will use our existing marine life inventories (many funded by OE), in comparison with maps generated in the proposed sonar survey, to determine how bottom topography affects fish distribution, and vice versa. This work will complement several existing NOAA programs such as MARMAP, SEAMAP, MARFIN and Charleston Bump research and monitoring projects that catalogue and monitor abundance of marine life, and that have contributed to an Internet map server (SEA-GEOFISH) that is updated (annually) to provide data on distribution and relative abundance of fish species (http://www.csc.noaa.gov/seageofish/). In addition, habitat complexity that interrupts an otherwise featureless seafloor often attracts a diversity of organisms, and mapping of such habitats will be useful for locating “hot spots” of biodiversity and marine life. Because fishes often produce such complex habitats such as depressions and burrows, which in turn provide habitat for symbionts and other diverse assemblages (Able et al. 1982; Coleman et al. 2005; Scanlon et al. 2005), mapping such features will enable us to inventory habitats that are likely to be “hot spots” of biodiversity.

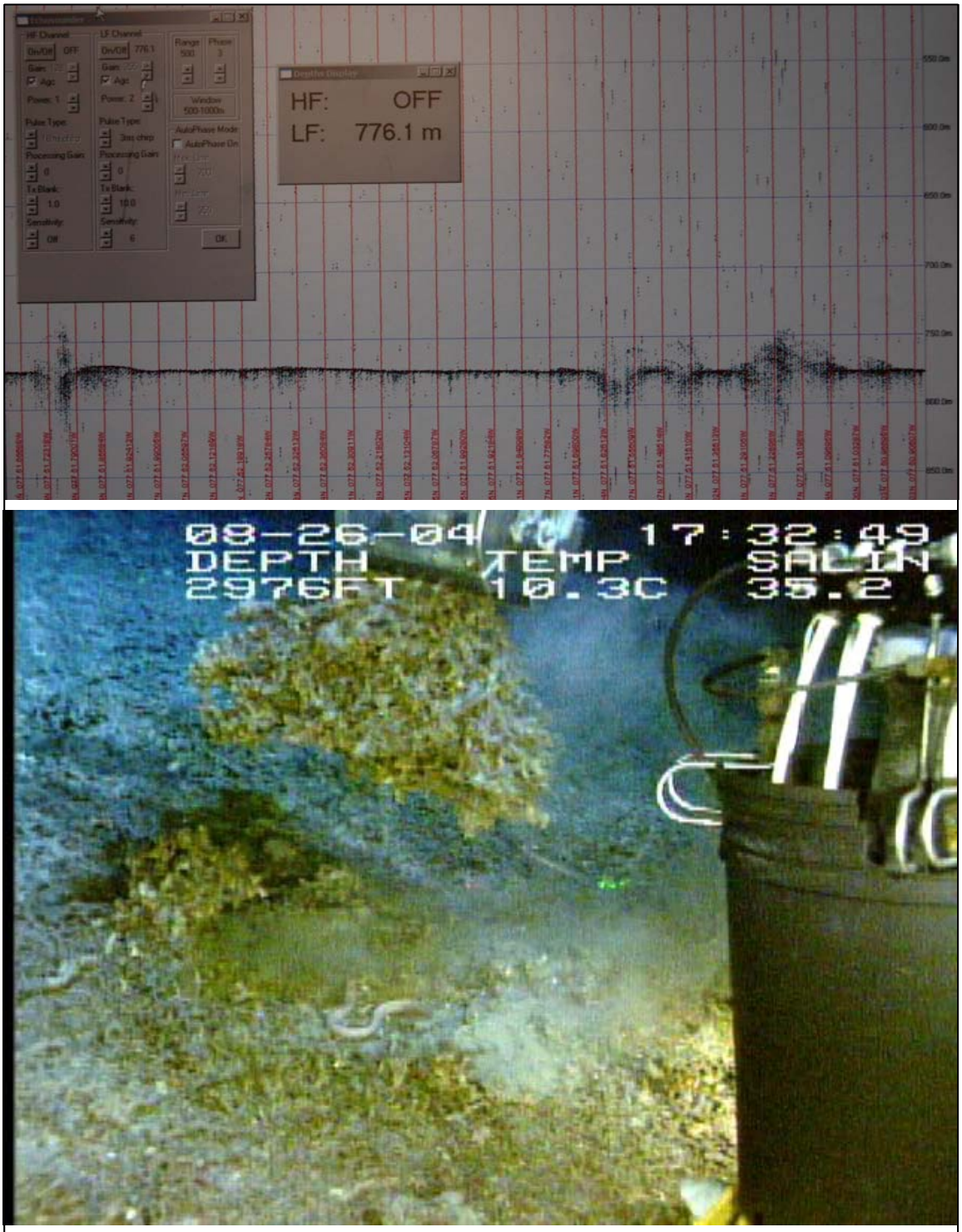
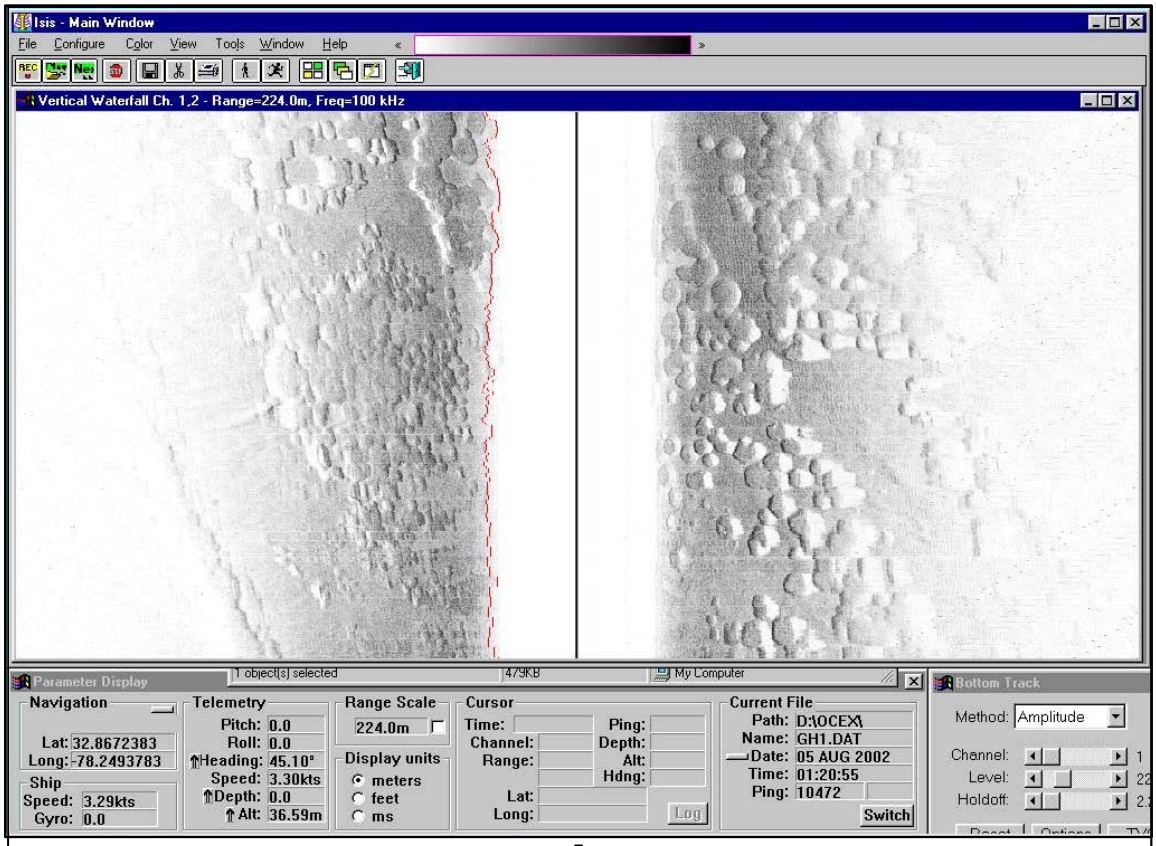


Figure 2. Top: Sonar record of coral mound habitat on the Blake Plateau, at ~775 m depth. Bottom: sampling such a coral mount using the JSL submersible. Such deepwater coral banks in shallower water (~100 m) have been shown to be important spawning grounds for reef fishes (Gilmore and Jones 1992) and may be important spawning grounds or resident habitat for wreckfish (*Polyprion americanus*), barrelfish *(Hyperglyphe perciformis*), red bream *(Beryx decadactylus*), other fishery species and other fishes on the Blake Plateau.



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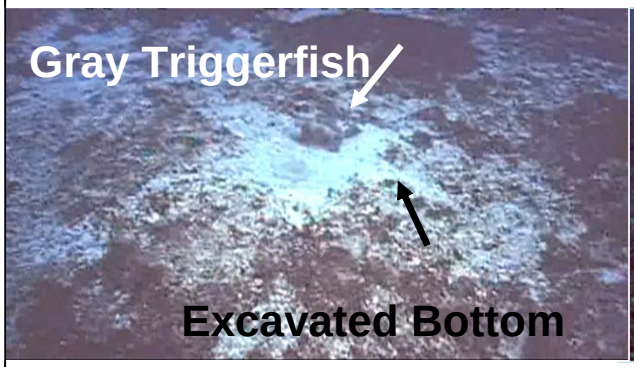

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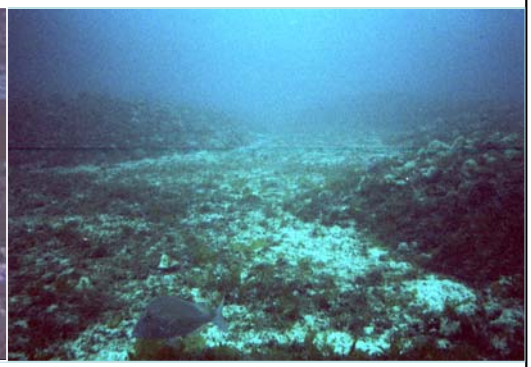

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Figure 3. Top: Pockmarked bottom mapped using side-scan sonar at a shelf-edge reef (~55 m depth) during our 2002 OE Expedition to shelf-edge reefs. Such pockmarks may indicate nest excavation by gray triggerfish (Bottom Left), as we have observed during our OE submersible dives (50 m depth), or may be excavated by red grouper and other species (Scanlon et al. 2005). Alternatively, they may represent gas seeps or solution holes. Additional rounded bottom features at shelf-edge reefs include mounds formed by tube worms (Bottom Right) and/or corals.

Characterization of Habitats and Ecosystems: Mapping of bottom topography, particularly complex topography, will enable us to characterize those benthic habitats that are most productive in terms of fisheries (e.g. Wenner 1983; Sedberry et al. 2001) and biodiversity (Wenner et al. 1983; Sedberry and Van Dolah 1984; Sedberry, Weinbach et al. 2005). Complex bottom topography in the SAB also has a profound effect on hydrography, and results in Gulf Stream deflection, upwelling, downwelling, and areas of high productivity (Sedberry et al. 2001; Bane et al. 2001). Recruitment patterns and success in fishery species is influenced by topographically-generated circulation patterns. Topographic mapping of benthic habitats will increase our understanding of how benthic and pelagic habitats and processes interact to create highly productive and diverse ecosystems. Sonar surveys will also be used to locate and map deep coral banks. Although some maps of coral mounds exist, improvements in navigation and sonar technology since those maps were made will enable us to pinpoint locations of coral banks, which are important fish habitats and areas of high fish productivity and diversity.
New Ocean Resources: Corals, sponges and other organisms increase bottom topography and have unique sonar signatures. Many of these taxa are desired for isolation of biologically active compounds, and mapping of these biotic features will aid in bio-prospecting for them. Although we will not conduct bio-prospecting, our mapping of bottom habitat will help in those efforts. These organisms also contribute to bottom complexity and prey abundance, which attract fishes.
Education: We will also develop educational materials regarding sonar technology, bottom mapping, EFH, the importance of complex habitat to fishes, and the role of fishes in shaping the seafloor. The public needs to be educated regarding the concept of EFH, HAPCs, and the science behind MPAs. This project will add considerably to knowledge and educational materials. We will utilize the educational web sites produced and maintained by OE and our institutions (e.g. http://www.csc.noaa.gov/seageofish/; http://oceanica.cofc.edu/) to promulgate educational materials.

Methods

We will use the NOAA Ship *Nancy Foster*, equipped with high-resolution multibeam and side scan sonar to map bottom features off the coast of the U.S. from North Carolina to Florida. Because of the expansive geographic area being considered, we will concentrate on important fishery grounds to map EFH. During the first year of the project, we will conduct sonar surveys, which will be subsequently ground-truthed (in Year 2) with ROV (Fig. 4-6). Mapping will concentrate on reef fish spawning grounds at the shelf edge and upper slope, particularly those that occur in proposed MPAs and in suitable habitats that are not being considered for additional protection as MPAs (e.g. Fig. 1, Fig. 4; Sedberry et al. in press). We will also concentrate on shelf-edge and upper slope locations where we expect to find biologically-engineered habitats such as locations where excavating fishes (tilefishes, red grouper, gray triggerfish) are found (e.g. Fig. 5). We will use an existing fishery database (http://www.csc.noaa.gov/seageofish/) to determine sites where excavating fishes occur (Fig. 5). We will also direct sonar mapping efforts toward historical or recently-mapped locations of coral mounds on the continental slope and Blake Plateau, including proposed deepwater coral HAPC (Fig. 6). The known coral mound areas are vast, and we will concentrate on those areas off South Carolina, near the Charleston Bump, where we have observed fishery species (wreckfish, *Polyprion americanus*) associated with coral mounds. EFH to be mapped includes shelf-edge reefs (45-100 m depths) and associated reef fish spawning sites, upper slope reefs (130-275 m depth), tilefish muds and pueblo habitats (165-275 m), deepwater coral (*Oculina, Lophelia, Dendrophelia*) banks (100-900 m), scarps and other complex bottom types. We will also map areas of extensive coral mounds, as these are important fish habitats and create complex refuges for a diversity of marine

organisms. We will use existing data on fish and coral distribution to find locations to initially map, then use broad multibeam survey to locate habitats that have the potential to support these species.

Sonar surveys will initially concentrate on shelf-edge reefs in depths from 50 to 200 m, between Cape Canaveral, Florida and Cape Fear, North Carolina. Because of the extensive geographic coverage, efforts will initially concentrate on proposed MPA sites and known spawning grounds off northern Florida, Georgia, South Carolina and North Carolina. We are especially interested in MPA sites that include spawning sites of economically valuable fishes (Fig. 4), but will also examine those MPA sites that possess species that excavate the bottom (Fig. 5), and which may be spawning there. Likewise, we will survey reefs that contain excavating and spawning species, but that are not proposed MPA sites, to determine the quality of proposed MPAs relative to other sites. Surveys will be conducted along complex bottom features (e.g. the shelf-edge reef), but will encompass adjacent smooth bottom.

We are familiar with the previous multibeam sonar surveys conducted by other NOAA offices, such as those at the shelf-edge reef off Georgia ("Savannah Scarp"), done by Gray's Reef National Marine Sanctuary (2001); and the surveys done by NOAA Fisheries (Panama City laboratory, 2003-04) in two of the six alternative MPA sites off South Carolina and two of alternative sites off Georgia. Our multibeam survey will not duplicate those efforts, but will concentrate on MPA alternatives that have not been surveyed, or areas within previously-surveyed MPAs that have not been surveyed, but which contain the fish species of interest..

Surveys will be conducted along lines that parallel the bottom feature being surveyed, with occasional cross-transects to further validate initial survey readings. Surveys will be conducted on two general scales. The broad-scale survey will be conducted at each site first, and will consist of high-resolution (4 m/pixel) multibeam sonar that will be used to map large-scale features within the proposed MPA sites and along similar reef features outside the proposed MPAs. Soundings will be recorded continuously using echosounders interfaced with GPS. Multibeam sonar data will be collected using a Multi-Beam 1002 Simrad System (30m-1000m) interfaced with Scientific Computer System (SCS) installed aboard the NOAA Ship *Nancy Foster*. The SCS includes a HYPACK Data Acquisition and Processing System, which will also record continuous data from the ship's Acoustic Doppler Current Profiler (ADCP).

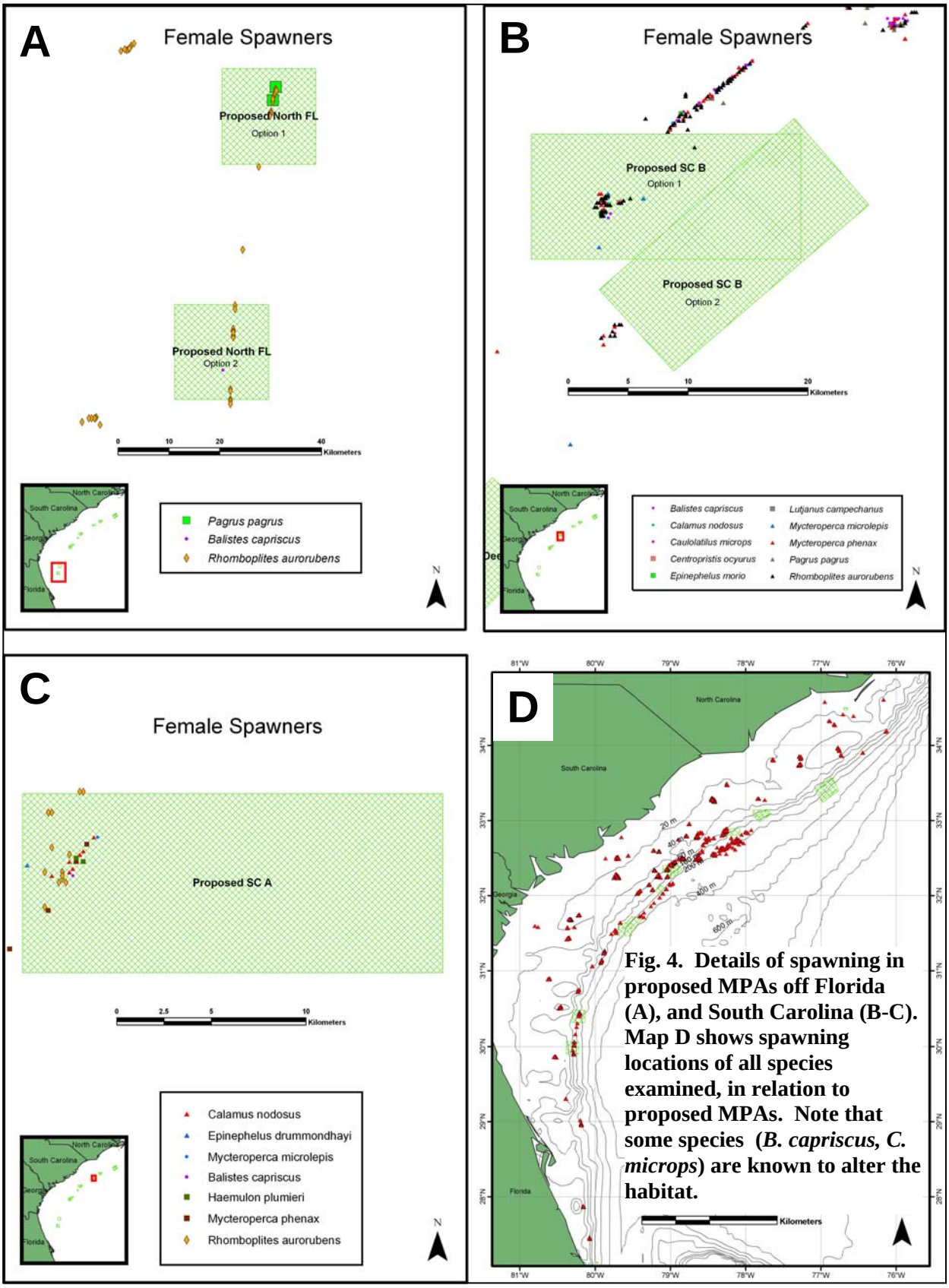

Fig. 4. Details of spawning in proposed MPAs off Florida (A), and South Carolina (B-C). Map D shows spawning locations of all species examined, in relation to proposed MPAs. Note that some species (*B. capriscus, C. microps*) are known to alter the habitat.

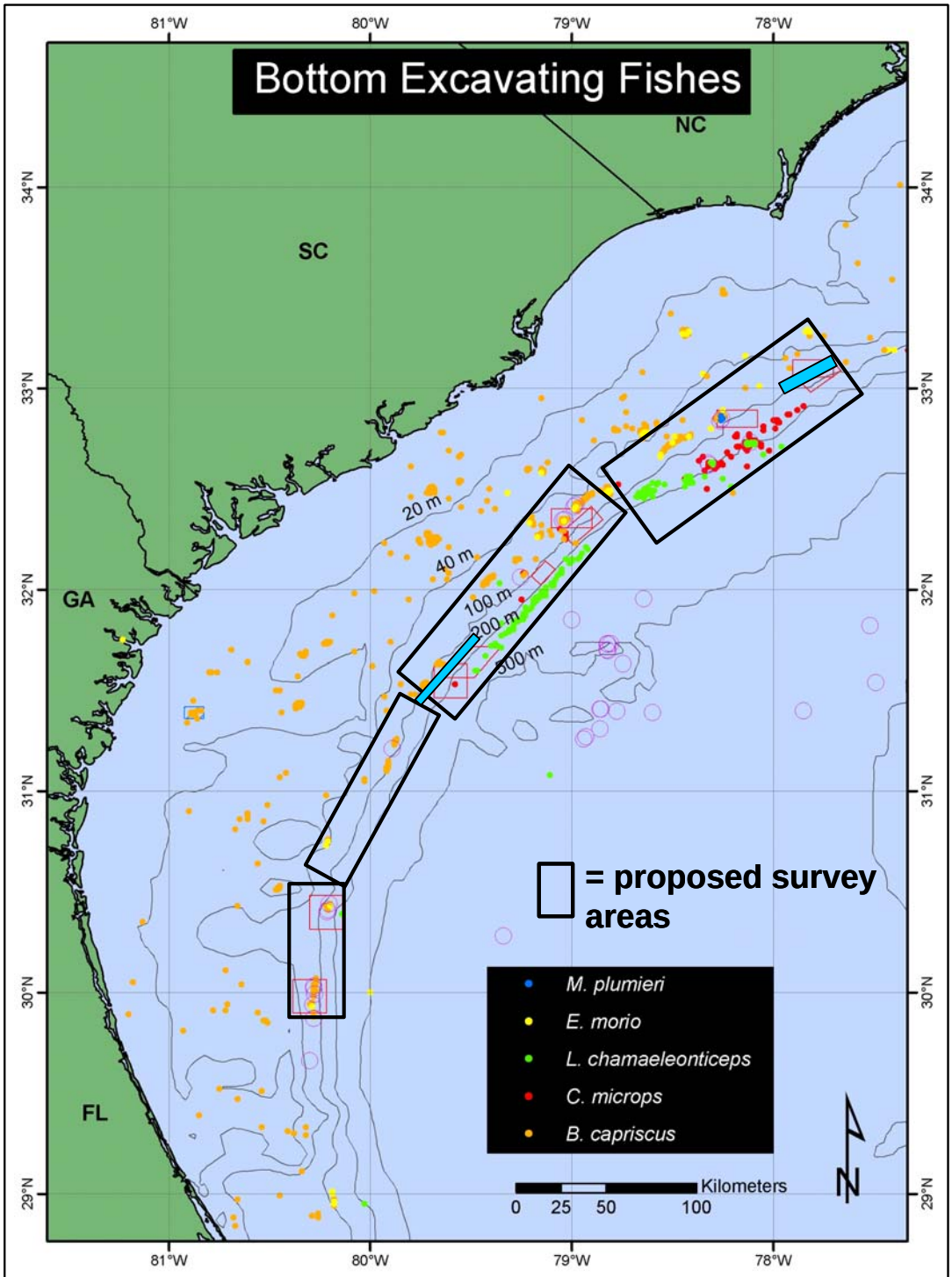

Fig. 5. Shelf-edge (40-100 m) and upper slope (130-225 m) areas to be surveyed. These areas include rugged and smooth bottom topography, proposed MPAs (red boxes), and locations where we have collected bottom-excavating fishes (dots). Some multibeam sonar data are already available from NOAA Fisheries and NOAA Sanctuaries on parts of some of the proposed MPAs (blue boxes), and proposed work will concentrate in MPAs.

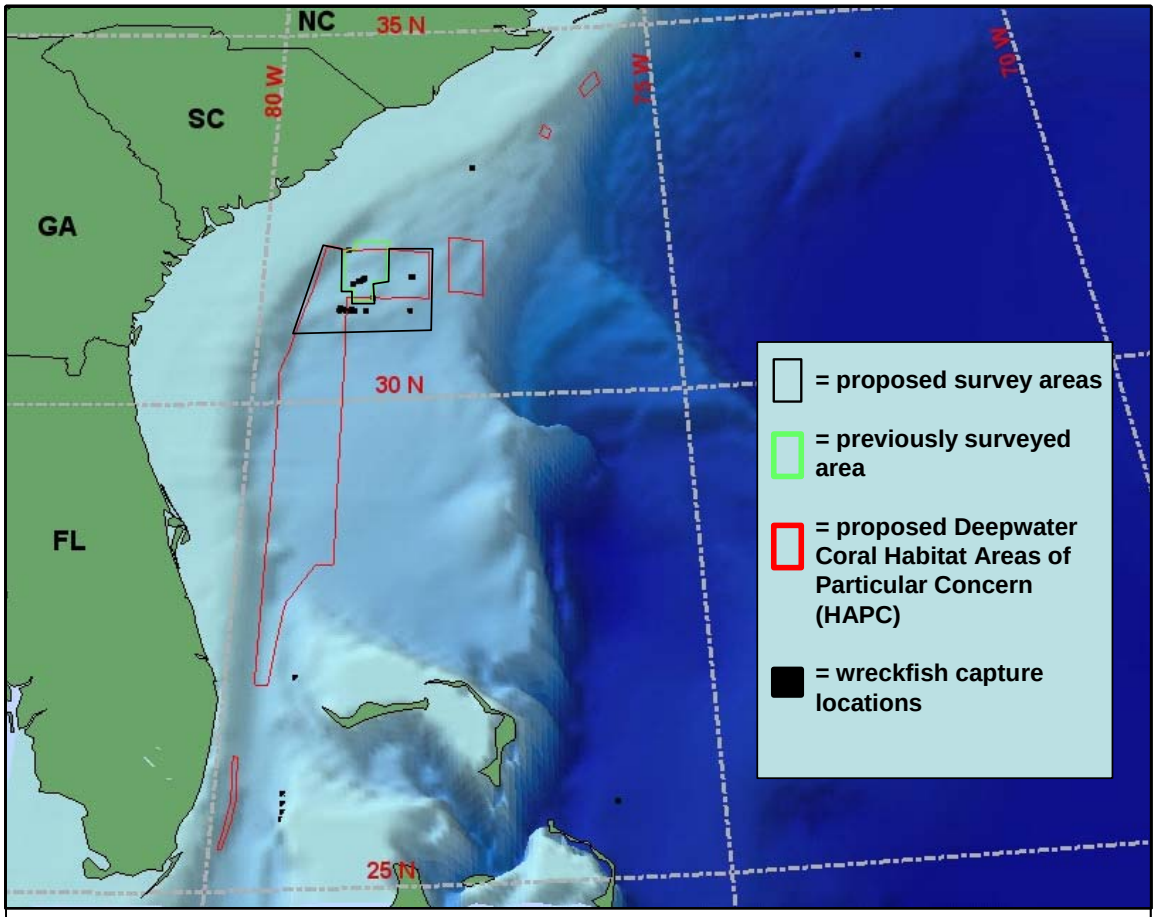

Fig. 6. Deepwater (300-900 m) coral areas to be surveyed. This area includes rugged bottom topography and coral mounds that are important habitats for wreckfish (*Polyprion americanus*), and a small portion of the proposed deepwater coral Habitat Areas of Particular Concern. Previously surveyed areas include single-beam and multibeam sonar surveys conducted by the investigators on the Charleston Bump.

A Sea-Bird SEACAT SBE-19 CTD or equivalent will be used to determine temperature and salinity profiles. Sound velocity profiles will be used to calculate sound velocity corrections for depth measurements. A dynamic motion sensor or heave, roll, pitch and motion sensor will collect heave, pitch and roll measurements to be applied to raw soundings data for correction during processing. Tidal time and ratio correctors will be obtained from NOAA/HSD and applied during at-sea post-processing to 6 min tidal values based on the Charleston (or other local) tide gauge. Positioning information will be collected using a Trimble DSM212L GPS Receiver or equivalent, with integrated DGPS VHF receiver. Differential corrections will be received from the Ft. Macon NC, Charleston SC or Miami FL radio beacons as appropriate. Antenna positions will be corrected for offset and layback and referenced to the position of transducer(s) in use at the time. Accuracy requirements will be met as specified in the NOAA Hydrographic Manual and Field Procedures Manual (FPM). The Horizontal Dilution of Precision and Estimated Position Error as specified in the FPM will be monitored during on-line data collection. If the positioning degraded beyond the acceptable limits while on line, the data will be either rejected or smoothed, depending on the extent of the affected data. Coastal Oceanographics HYPACK software or equivalent will be used for data acquisition. Processing

of sounding data will be accomplished using NOAA Hydrographic Processing System included in HYDROSOFT 9.4, Mapinfo software, and the HPS-MI MapBasic application (or equivalent/upgrade). Post processing will be done using CARIS HIPS software that is used aboard the *Foster*. CARIS HIPS includes statistical-based data cleaning and processing, and data validation tools to translate raw sounding data into GIS-based maps and shapefiles.

Multibeam sonar surveys will be followed by side-scan sonar transects through particular features of interest, or through areas where fish and coral species of interest have previously been observed or collected. A 100 Khz towed side scan sonar will be used to obtain detailed bottom maps along transects. Transect data will be digitally assembled into mosaics for each MPA site or area of interest. Post processing will be done using CARIS SIPS software. CARIS SIPS includes statistical-based data cleaning and processing, and data validation tools to translate raw sounding data into GIS-based maps and shapefiles. Habitat data from all sonar surveys will be incorporated into the GIS database (SEA-GEOFISH; http://www.csc.noaa.gov/seageofish/) containing historical data on hydrography and fish distribution, to aid in characterization of reef fish spawning sites and other habitats based on biological and physical data.

During Year 2 of the project, bottom features mapped during Year 1 will be confirmed using ROV equipped with video and still cameras, and CTD. Where distinctive features such as pock marks, burrows, holes, mounds or caves are noted on sonar images, an ROV will be used to ground-truth the sonar image. The ROV will be used to determine if the bottom feature is constructed by living organisms (e.g. fish burrows) or composed of living organisms (e.g. worm tube mounds, coral mounds), or possibly caused by water seeps (CTD measurements). The ROV will be lowered to the bottom feature and the feature will be recorded on videotape. Exact positioning may be problematic, but our preliminary surveys (Sedberry, Cooksey et al. 2004) indicate that these features occur in large "fields", which may enable ROV transects. In addition the *Foster* has positioning systems that we believe will enable us to hold station over specific bottom features in order to visually confirm their composition and location.

Sonar and ROV surveys will be accomplished on two 26-day cruises in 2006 (sonar) and 2007 (ROV). Each cruise will have two 13-day legs, with a port call in Charleston SC. The investigators will request, through NOAA OE, contacts within the NOAA National Ocean Service to ensure that bathymetry is acquired in a manner that meets NOS Hydrographic Manual and Office of Coast Survey (OCS) Field Procedures Manual specifications. Dr. Sedberry has previously obtained clearance from the U.S. Navy to conduct (and release data from) high-resolution sonar surveys in the proposed areas. He is in the process of having this clearance renewed.

Justification

Historical and recent research (1973-present) conducted by the SCDNR has described species assemblages, mapped spawning locations of economically valuable species, and tracked oceanographic conditions associated with spawning for deep-reef (50-600 m) fishes found from North Carolina to Florida. Mapping of spawning locations in 28 species of the SAFMC Snapper-Grouper management unit and other ecologically dominant species has indicated particular locations that are utilized by several different species, at various times of the year (Fig. 1). Some of these multi-species spawning sites coincide (somewhat by design) with proposed no-take MPAs under consideration by the SAFMC. Subsequent to developing spawning maps, we are in the process of deploying satellite-tracked drifters during peak spawning times to determine the fate of progeny from spawning aggregations that will be protected if an effective MPA network design is implemented that will protect spawners. In spite of this significant progress in designing an MPA network to increase spawning and fish biomass, several important

questions remain that must be addressed in order to implement ecosystem-based fishery management plans based on networks of protected areas for spawners and recruits. These include:

- What is the areal extent of spawning habitat for economically valuable and ecologically dominant reef deep reef fishes?
- Some species appear to migrate to known spawning locations during the spawning season. Are a few sites important for these fishes distributed from Cape Hatteras to the Florida Keys? How can protecting those spawning sites prevent overfishing during times when these species are not living in no-take MPAs? What are the important non-spawning habitats (migratory routes, juvenile habitats) and should they be protected?
- Is the concentration of spawning in certain areas an artifact of sampling, or do these areas possess unique features that are essential for spawning in many fishes?
- What are the unique features of spawning locations? What are the physical and biological characteristics of these spawning locations?
- Do those characteristics occur in previously unsampled areas in the depth range? Where?
- What is the oceanographic connection among known spawning grounds and nursery areas? Can a network of MPAs be designed to take advantage of spawning behavior and oceanographic conditions, that will result in maximum recruitment with minimum impact resulting from reduced access to the fishing grounds?
- What distinguishes pits made by gas or water seeps from pits made by fish; what distinguishes pits, mounds and other features made by different fish species?
- Where are bioengineered habitats formed by fishes and corals, and do these constitute EFH or HAPC that support fishery species and increase diversity?

In the re-authorization of the Magnuson-Stevens Fishery Conservation and Management Act, through the Sustainable Fisheries Act, the U.S. Congress included provisions that required regional Fishery Management Councils (FMCs) to identify essential fish habitat (EFH). Such EFH should include "those waters and substrate necessary to fish for spawning, feeding or growth to maturity" (MSFMCA 1996; Schmitten 1999). While the definition is broad in scope, and perhaps includes most aquatic habitats, it is important to identify those regions and habitats that are essential for various life history stages of fishes of economic importance. Such essential areas could include specific substrates (e.g., coral banks, mounds and reefs), species associations (e.g., tube worms, sponge and/or coral) and unknown factors that result in high abundance, biomass, diversity or spawning potential of fishes. The Magnuson Act re-authorization also provided for recognition of HAPC for various fish stocks or assemblages (e.g., Murawski et al. 2000; Reed 2000). HAPC are locations where some user activities (e.g., trawling, bottom longlining) are banned because of particularly sensitive habitats or species assemblages such as ivory tree coral (*Oculina varicosa*) and associated organisms (Reed 2000). EFH regulations [Section 600.815(a)(9)] encourage the Fishery Management Councils to identify HAPCs based on one or more of the following considerations (Federal Register 2002):

1. The importance of the ecological function provided by the habitat.
2. The extent to which the habitat is sensitive to human-induced environmental degradation.
3. Whether, and to what extent, development activities are, or will be, stressing the habitat type.
4. The rarity of the habitat type.

In order to manage fisheries under EFH and HAPC provisions, it is necessary to recognize and map EFH and HAPC, and to more clearly define it in relation to the fishery management unit (e.g., the SAFMC Snapper/Grouper Management Unit). As a first step, it is essential to map distributions of fishery species of concern, and some of this work has been completed (Sedberry

et al. 2005; http://www.csc.noaa.gov/seageofish/). Mapping efforts have concentrated on individual species, areas of high biomass or diversity, and locations of capture of fish in spawning condition. Less effort has been spent on sonar mapping of the habitats that support individual species, high biomass or diversity, and spawning habitats and substrates for fishes, particularly in deep water. By using sonar to map habitats that are known to support high diversity or biomass of fishes, or which provide spawning grounds, and by determining the characteristics of these habitats, additional areas that may provide such EFH can be rapidly mapped with sonar surveys.

Off the southeastern United States, priority species and habitats for EFH and HAPC consideration include the 73 species of the SAFMC Snapper/Grouper Management Unit (e.g., snappers, groupers, porgies, grunts, tilefishes) and their hard-bottom and sponge-coral habitats (Coleman et al. 2000). This project will address EFH and HAPC issues in the Snapper/Grouper fishery, but data on associated species of reef fish and species dependent on biologically-structured complex habitats will also be provided.

Data collected by SCDNR from 1973 through 2005 will be available to determine areas that support greater abundance, biomass and/or diversity of fishes. The databases can also be examined to describe distribution of individual species (e.g. Fig. 5) in relation to bottom and hydrographic features, where those features have been mapped. This project will provide additional data on bottom features in areas that have not been mapped, and will place historical fish collection data in a habitat context. Mapping of EFH and HAPC for reef fishes off the southeastern U.S. Atlantic coast is of particular importance at this time. The consumption of fishes by humans has increased dramatically in the last several decades, and many local species are severely overfished or in danger of being so (Coleman et al. 2000; NMFS 2005).

Many economically important reef fish species share a suite of life history and behavioral characteristics that make them particularly susceptible to overexploitation. These characteristics include long life, large adult size, late maturity, protogyny, and spawning in aggregations and/or at sites that are predictable in time and space (PDT 1990; Coleman et al. 2000; Musick et al. 2000; Sala et al. 2001). We have extensive data on spawning times and locations for 28 species of reef fish (Sedberry et al. in press), but we lack data on characterization of the spawning sites and the features that make them attractive to spawning fishes. Spawning aggregations in reef fishes are believed to correspond spatially and temporally with bottom features and associated hydrography that insure greatest survival of early life history stages. For this reason, many species utilize the same locations for spawning, even at different times of the year (Carter et al. 1994; Carter and Perrine 1994; Domeier and Colin 1997; Sala 2001). These hydrographic features are often associated with prominent bottom features that influence circulation near (and downstream from) the spawning banks (Carter et al. 1994; Sedberry et al. 2001; Govoni and Hare 2001). Many reef fishes with pelagic eggs and larvae spawn in the vicinity of gyres near the shelf edge (Johannes 1978). Such topographically-produced gyres (e.g., the Tortugas Gyre off Florida) are implicated in removal of pelagic eggs from the spawning site, thus reducing predation, while retaining fish eggs and larvae for the ultimate return of larvae to the shelf at later developmental stages that can avoid some predation (Lee et al. 1992; Limouzy-Paris et al. 1997; Lee and Williams 1999). It is critical to map bottom topography that may be important in the survival of early life history stages of fishes. Such areas might be considered EFH or HAPC, and it is important to map prominent and persistent bottom and associated hydrographic features in relation to distribution of fish larvae, juveniles and adults to determine the spatial relationships among life history stages and hydrographic features.

As a result of overfishing and the inability of traditional methods to reverse this trend, the SAFMC has proposed a series of MPAs that could include no-take marine reserves. The

SAFMC has recently gone through an exercise in siting MPAs that included obtaining input from user groups, interested parties, and the general public, along with some review of existing biological and habitat data (SAFMC 2004). Of prime concern is protecting those habitats and locations that are essential to completing the life cycles of overfished species. This SAFMC siting process highlighted some significant problems with gaps in knowledge of distribution of habitat, species and spawning locations [see also Sale et al. (2005)]. These gaps include mapping of the bottom in the proposed MPAs to determine if they contain habitats that support the species that the MPAs will be established to manage. Maps of adjacent areas, or areas outside proposed MPAs where priority species are known to occur and spawn, are also needed to determine if the proposed MPA sites protect the correct habitats and species. High fish biomass is known to be associated with hard bottom vs. sand bottom habitat (Wenner 1983), but additional study of distribution of individual reef fish species and spawning sites in relation to bottom habitats and faunas, and the relationship of bottom features to hydrographic features and proposed MPA sites, is needed.

This project will provide a summary of data on bottom habitats in relation to known fish distribution and abundance, prior to any MPA designation in the SAB. When the sonar data are brought into the existing GIS and internet map server (http://www.csc.noaa.gov/seageofish/), this project will provide readily accessible and simple visualizations (maps) of the distribution, abundance, biomass and diversity of species in relation to detailed maps of habitat features. In addition to simple distribution maps for species, the analysis will provide maps of areas of above-average fish abundance, biomass and diversity and locations of capture of priority reef fishes in spawning condition, in relation to detailed habitat features. These maps will provide essential basic information on fishes needed to develop ecosystem-based management plans. Links from the internet map server can also be made to ocean education web sites (e.g., Project Oceanica, www.cofc.edu/oceanica). By linking research, management and education, the project will benefit fish and fisheries by integrating conservation of managed species, fisheries management and public education, resulting in improved conservation and management of reef fishes in the region.

Institutions, Personnel, Project Management and Complementary Funding

South Carolina Department of Natural Resources: G.R. Sedberry (fishes and habitats of the SAB; project and program management; ocean sciences education); J.K. Loefer (fishes and fish habitats of the SAB); P. Weinbach (fisheries and habitat GIS); J.A. Stephen (database construction and management)

College of Charleston: L.R. Sautter (geology of the SAB; project management; ocean sciences education); student assistants

Florida State University: F.C. Coleman and C.C. Koenig (fish and habitats of the southeastern U.S.; program and project management)

U.S. Geological Survey: K.M. Scanlon (geology of the SAB; sonar survey and interpretation of bioengineered habitats)

South Carolina Public Schools: S. Morrison (secondary education)

Dr. Sedberry will be Principal Investigator on the project. He has 27 years experience working with the fishes, fisheries and fish habitats of the region. He also has considerable experience at sea in sampling and observing fishes, benthos and plankton, and he has experience with sonar surveys of fishery habitats (Charleston Bump). He has many years experience in managing research projects and programs and in administrating research programs. Co-PI is Leslie Sautter, College of Charleston, who has considerable experience with the geology of deep reef systems. Dr. Sautter has participated in five previous OE Expeditions and has considerable

experience at sea, and in developing educational materials from OE Expeditions. Drs. Coleman and Koenig are experienced in the fishes and fish habitats of the region and, together with Dr. Scanlon, first explored the idea of fishes as possible sources of peculiar shallow depressions found on deep reefs in the Gulf of Mexico. They have considerable experience in interpreting sonar data. Other personnel include the SCDNR Marine Division GIS manager, P. Weinbach. He will add the sonar data to the existing fisheries GIS. J.A. Stephen, our database manager, will manage all data collected and format it for incorporating into the GIS, and will be assisted by J. Loefer in data management and cruise logistics.

See appended CVs and statements of current funding for additional details of the investigators qualifications and relevant current funding.

The proposed work will complement existing and historical NOAA programs in which the Principal Investigator is involved (OE, SEADESC, MARMAP, SEAMAP, MARFIN, ESDIM, Charleston Bump). These projects all include efforts aimed at mapping fish and coral habitats using historical oceanographic, fish distribution, and previous OE data collected by the investigators. The proposed project will complement and substantially improve these efforts, by enabling us to put historical biological and substrate sampling data (e.g. fish distribution maps, sediment/rock samples, coral observations and samples), collected from a variety of projects, in the context of surrounding bottom features. Mapping of bottom topography, bottom type and fish distributions in relation to additional ongoing SCDNR oceanographic studies (such as tracking currents using satellite-tracked drifters) will assist in establishing Marine Protected Areas (MPAs) that are proposed for fishery management in the SAB. The use of new sonar technology and data processing will allow us to map, groundtruth and verify the importance of specific habitat features to biological assemblages, and will complement several sampling programs that are assessing the biological assemblages.

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Summary of Results From Past Ocean Exploration Support

The following is a list of publications (including theses), presentations, and other outreach based on previous OE expeditions on which we have participated.

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Presentations

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Educational Web Sites

In addition to the many educational resources found at the Ocean Exploration web site (http://www.oceanexplorer.noaa.gov/explorations), the investigators have created several additional web sites that contain detailed visual material and which are geared toward specific educational audiences. They can be found at http://oceanica.cofc.edu/.

MSDS Sheets

MATERIAL SAFETY DATA SHEET

1. PRODUCT DESCRIPTION

Product Name: Ethanol, 95%
Product Code(s): 15-4708A, 15-4708CA, 15-4724A, 89-2301, 89-2305, 19-1184, 19-1176, 15-4725, 19-1177, 76-6200, 86-1281, 86-1283, 86-1285, 84-1135, 10-1026, 10-1036, 84-0887
Size: 1 oz, 75 mL, 350 mL, 500mL, 4L, 20L
Chemical Name: Does not apply, product is a mixture
CAS Number: Does not apply, product is a mixture
Formula: See Section 2
Synonyms: Alcohol, Ethyl alcohol
Distributor: Carolina Biological Supply Company
2700 York Road
Burlington, NC 27215
Chemical Information: 800-227-1150 (8am-5pm (ET) M-F)
Chemtrec (Transportation Spill Response 24 hours): 800-424-9300

2. COMPOSITION/INFORMATION ON INGREDIENTS

Principal Hazardous Components:
Ethyl alcohol (CAS#64-17-5) 95%
Methyl isobutyl ketone (Denaturant) (CAS# 108-10-1) 4%
TLV and PEL units:
Ethyl alcohol: ACGIH-TLV 1000ppm (TWA)
OSHA-PEL 1000ppm (TWA)
Methyl isobutyl ketone: ACGIH-PEL 50 ppm (TWA), STEL 75 ppm;
OSHA-PEL 50 ppm (TWA), STEL 75 ppm

3. HAZARD IDENTIFICATION

Emergency Overview: Concentrations below 1,000 ppm usually produce no signs of intoxication. Exposure to concentrations over 1,000 ppm may causes headache, irritation of the eyes, nose, and throat, and if continued for an hour, drowsiness and lassitude, loss of appetite and inability to concentrate.
Potential Health Effects:
Eyes: May cause irritation.
Skin: May cause irritation.
Ingestion: May cause gastrointestinal discomfort.
Inhalation: May cause irritation to respiratory tract.

4. FIRST AID MEASURES

Emergency and First Aid Procedures:
Eyes - Flush with water for at least 15 minutes, raising and lowering eyelids occasionally. Get medical attention if irritation persists.
Skin - Thoroughly wash exposed area for at least 15 minutes. Remove contaminated clothing. Launder contaminated clothing before reuse. Get medical attention if irritation persists.
Ingestion - If swallowed, if conscious, give plenty of water. Immediately call a physician or poison control center. Never give anything by mouth to an unconscious person.
Inhalation - Remove to fresh air. Give oxygen if breathing is difficult; give artificial respiration if breathing has stopped. Keep person warm, quiet, and get medical attention.

5. FIREFIGHTING PROCEDURES

Flash Point(Method Used):(cc)55.6F-Ethyl alcohol
NFPA Rating: Health: 0
Fire: 3
Reactivity: 0
Extinguisher Media:
Use dry chemical, CO2 or appropriate foam.
Flammable Limits in Air % by Volume: Ethyl alcohol: LEL 3.3%, UEL-19%
Autoignition Temperature: Ethyl alcohol-793F
Special Firefighting Procedures:
Firefighters should wear full protective equipment and NIOSH approved self-contained breathing apparatus.
Unusual Fire and Explosion Hazards: Extremely flammable. Vapors are heavier
than air and can travel distances to ignition source and flash back.

6. SPILL OR LEAK PROCEDURES

Steps to be Taken in Case Material is Released or Spilled:
Ventilate area of spill. Eliminate all sources of ignition. Remove all non-essential personnel from area. Clean-up personnel should wear proper protective equipment and clothing. Absorb material with suitable absorbent and containerize for disposal.

7. SPECIAL PRECAUTIONS

Precautions to be Taken in Handling or Storing: This material should be kept in an area suitable for the storage of flammable liquids. Bond and ground containers when transferring liquid.
Other Precautions: Keep oxidizing materials and strong acids away. Wear splash-proof chemical safety goggles and rubber gloves at all times during cleanup process.

8. SPECIAL PROTECTION INFORMATION

Respiratory Protection(Specify Type):
A NIOSH/MSHA chemical cartridge respirator should be worn if PEL or TLV is exceeded.
Ventilation:
Local Exhaust: Yes
Mechanical(General):Yes
Special: No
Other: No
Protective Gloves:
Rubber, neoprene, PVC, or equivalent.
Eye Protection:
Splash proof chemical safety goggles should be worn at all times.
Other Protective Clothing or Equipment:
Lab coat, eye wash, and safety shower.

9. PHYSICAL DATA

For ethanol:
Molecular Weight: 46.07
Melting Point: -117°C
Boiling Point: 78°C
Vapor Pressure: 43 mmHg at 20°C

Vapor Density(Air=1): 1.59
Specific Gravity(H2O=1): .81 @ 20°C
Percent Volatile by Volume: 100%
Evaporation Rate(Butyl Acetate=1): 3.3
Solubility in Water: 100%
Appearance and Odor: Clear liquid, fruity odor

10. REACTIVITY DATA

Stability: Stable
Conditions to Avoid: Heat, sparks, open flame
Incompatibility(Materials to Avoid): Strong oxidizing agents.
Hazardous Decomposition Products: Carbon dioxide. Carbon monoxide
Hazardous Polymerization: Will not occur

11. TOXICITY DATA

Toxicity Data: To the best of our knowledge, the toxicological properties of this mixture have not been thoroughly evaluated. Data is listed for individual components.
Ethyl alcohol: orl-rat LD50: 7060 mg/kg; ihl-rat LC50: 20,000 ppm/10H
Methyl isobutyl ketone:orl-rat LD50 5080 mg/kg; ihl-rat LC50 8000 ppm/4H

Effects of Overexposure:
Acute: See section 3
Chronic: Ethyl alcohol: Mutation data cited. Reproductive effects data cited. Turmorigenic data cited. Not listed as causing cancer by IARC, NTP, or OSHA.
Methyl isbutyl ketone: No chronic effects data found. Not listed as causing cancer by IARC, NTP, or OSHA.
Conditions Aggravated by Overexposure: Pre-existing conditions of the skin, eyes, throat, liver.
Target Organs: Skin, eyes, nose, throat
Primary Route(s) of Entry: Ingestion, inhalation

12. ECOLOGICAL DATA

EPA Waste Numbers: Methyl isobutyl ketone (U161) is considered a hazardous waste if and when it is discarded.

13. DISPOSAL INFORMATION

Waste Disposal Methods: Dispose in accordance with all applicable Federal, State and Local regulations.
Always contact a permitted waste disposer (TSD) to assure compliance.

14. TRANSPORT INFORMATION

Description: Ethanol solutions, 3, UN1170, II

15. REGULATORY INFORMATION

EPA TSCA Status: On TSCA Inventory
Hazard Category for SARA Section 311/312 Reporting: Acute

Product or Components	SARA EHS Sec. 302 TPQ	SARA Sec. 313 Chemicals Name List	SARA Sec. 313 Chemicals Chemical Category	CERCLA Sec. 103 RQ lbs.	RCRA Sec. 261.33
Ethyl alcohol	No	No	No	No	No

Methyl isobutyl ketone	No	Yes	No	5000	Yes

16. ADDITIONAL INFORMATION

The information provided in this Material Safety Data Sheet represents a compilation of data drawn directly from various sources available to us. Carolina Biological Supply makes no representation or guarantee as to the suitability of this information to a particular application of the substance covered in the Material Safety Data Sheet. Any employer must carefully assess the applicability of any information contained herein in regards to the particular use to which the employer puts the material.

Glossary

ACGIH.....American Conference of Governmental Industrial Hygienists
CAS Number..Chemical Services Abstract Number
CERCLA.....Comprehensive Environmental Response, Compensation, and Liability Act
DOT.....U.S. Department of Transportation
IARC.....International Agency of Research on Cancer
N/A.....Not Available
NTP.....National Toxicology Program
OSHA.....Occupational Safety and Health Administration
PEL.....Permissible Exposure Limit
ppm.....parts per million
RCRA.....Resource Conservation and Recovery Act
SARA.....Superfund Amendments and Reauthorization Act
TLV.....Threshold Limit Value
TSCA.....Toxic Substances Control Act